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Bioefficacy of various doses of 2, 4-D Ethyl ester 80% EC on Weed growth, Crop yield of Maize and the Residual effect on succeeding Pea crop

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Abstract

A field investigation was carried out to test the bioefficacy of 2, 4-D Ethyl ester 80% EC at various doses (Sponsor vs Market sample) to control the weeds in maize crop. 2, 4-D Ethyl ester 80% EC was applied at various doses as post emergence and its market sample was also used, atrazine also applied as post emergence. All weed control treatments significantly reduced the density as well as dry matter accumulation of weeds over weedy check during both the years. The maximum suppression of density as well as dry matter accumulation of weeds and highest WCE were obtained with the successive increase in the doses of 2, 4-D EE (SS) from 450 to 1800 g a.i./ha resulted decreased density of dominant BLWs. None of the doses of 2, 4-D EE (SS or MS) was found much effective towards density of grassy weeds. Among herbicidal treatments, maximum grain yield (4507 kg/ha and 4743 kg/ha) and percent increase in the grain yield (61.12% and 70.6%) was achieved with the application of atrazine at 250ga.i./ha applied as post emergence during both the years.

Keywords*: Bioefficacy, 2, 4-D EE, atrazine, residual and maize*

1. Introduction

Maize (*Zea mays* L.) is the world's third leading cereal crop after wheat and rice. It is belong to family *Poaceae* and is one of the most important cereal crops in the world agricultural economy both as food and fodder crop and is regarded as queen of cereals. Maize grains are used for human consumption, feed for poultry and livestock, for extraction of edible oil and also for starch and glucose industry. It is called as a miracle crop with very high yield potential. It occupies an important position in the world economy and trade as a food, feed and industrial grain crop (Azizi *et al*., 2012). In India, maize is grown over an area of 8.33 million ha with an annual production of about 16.68 million tones and an average productivity of about 2015 kg/ha (Mehmeti *et al*., 2011). In the world it accounts for 8 and 25 per cent of the area and production of cereals, respectively.

Yield in maize was reduced as much 86 percent when weeds were not controlled. Therefore, weed control plays an important role in maize production ensuring an acceptable yield. Weed control in maize is carried out mainly by mechanical and chemical methods, but herbicide use is increasing, along with increases in growing areas and production costs. 2, 4-D belongs to the group of phenoxy herbicides, and its various formulations are used for weed control. The herbicidal effect of 2, 4-D was proven in wheat, beans, potato, sugarcane and soybean (Reddy and Reddy, 1999). Triazines have favorable effect, on crop plants at sub-lethal doses. Atrazine increased total nitrogen, protein content and yield of corn and physiological process in sorghum (Sairam *et al*., 1988). Thus, the experiment was conducted to study the effect of 2, 4-D and atrazine at different herbicidal doses on growth and yield of maize and its residual effect on succeeding crop.

2. Materials and Methods

The field experiment was conducted at N.E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar during two consecutive year of 2012-13

and 2013-14. The Crop Research Centre where the experiment was conducted is located at 29° N latitude, 79.3° E longitude, and at an altitude of 283.84 metres above the mean sea level. The soil was loamy, medium in organic matter (0.67%), available phosphorus (17.5 kg/ha) and potassium (181.2 kg/ha) with pH 7.5. The experiment consisted of eight treatments including untreated (control) and laid out in randomized block design (RBD) with three replications. The treatments were as follows of 2,4-D Ethyl ester 80% EC (sponsor sample) at 450, 900, 1350 and 1800g/ha and one dose of market sample at 900g/ha applied as post emergence, Atrazine 50% WP at 250 g/ha applied as post emergence to required volume of 500 l/ha. Weedy check also included in experiment to compare the efficacy of herbicidal treatments. Maize variety "Gaurav" was seeded on July24 of *kharif* 2012 and June6 of kharif 2013. Knap sack sprayer fitted with boom along with flat fan nozzle was used to apply the herbicidal solution. The recommended fertilizers (150:60:40NPK ha^{-1}) were applied in the form in the Urea (N), single super phosphate (P) and muriate of potash (K). Full dose of phosphorus and half of nitrogen and potassium were applied at the time of sowing. Remaining of 50% of nitrogen and potassium were applied at 25 Days after Sowing (DAS) as top dressing. Weeds were recorded species wise in each plot at 40 and 60 days after sowing (DAS) with the help of quadrate of $0.25m^2$ for the area marked for observation. The weed after uprooting are cleaned and dried in oven at 72^0C temperature and weed control efficiency was calculated by using the formula WCE = (weed biomass in unwedded control– weed biomass in managed treatment)/ weed biomass in unweeded control x 100. Besides observations for number of plants ('000'/ha), number of cobs ('000'/ha), number of grains/cob, 100 grain weight and grain yield were taken. Data recorded were statistically analyzed according to Gomez and Gomez (1984). Means were compared at 5% levels of significance by the least significant difference (LSD) test.

3. Result and Discussion

Table 1: Effect of treatments on density and total dry weight of weeds at 40 DAA during 2012 and 2013.

Treatments	Dose (g/ha)	Weed density (no./m^2) 2012							Weed density (no./m^2) 2013						
		E. colona	*D.aegypticum*	*D.sanguinalis*	*D.arvensis*	*P.niruri*	*C.argentia*	*C.rotundus*	*E. colona*	*D.aegypticum*	*D.sanguinalis*	*D.arvensis*	*P.niruri*	*C.argentia*	*C.rotundus*
2,4-D EE 80% EC (SS)	450	4.7(21.3)	3.8(13.3)	4.0(14.7)	2.2(4.0)	1.5(1.3)	2.2(4.0)	4.9(22.7)	5.9(34.7)	4.6(20.0)	4.4(18.7)	2.5(5.3)	1.9(2.7)	2.2(4.0)	5.4(28.0)
2,4-D EE 80% EC (SS)	900	4.6(20.0)	3.7(12.7)	3.8(13.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.1(8.7)	5.6(30.7)	4.4(18.7)	4.3(17.3)	1.0(0.0)	1.0(0.0)	1.2(0.7)	3.4(10.7)
2,4-D EE 80% EC (SS)	1350	4.4(18.7)	3.5(11.3)	3.8(13.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.9(7.3)	5.5(29.3)	4.4(18.7)	4.1(16.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.2(9.3)
2,4-D EE 80% EC (SS)	1800	4.3(17.3)	3.7(12.7)	3.7(12.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.6(6.0)	5.3(26.7)	4.3(17.3)	4.3(17.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.7(6.7)
2,4-D EE 80% EC (MS)	900	4.7(21.3)	3.5(11.3)	4.0(14.7)	1.5(1.3)	1.0(0.0)	1.0(0.0)	3.4(10.7)	5.6(30.7)	4.4(18.7)	4.1(16.0)	1.5(1.3)	1.0(0.0)	1.2(0.7)	3.5(11.3)
Atrazine 50%WP	250	3.3(10.0)	2.4(4.7)	3.7(2.7)	3.0(8.7)	3.1(8.7)	3.3(10.0)	9.3(85.3)	3.1(8.7)	3.0(8.0)	3.0(8.0)	3.1(8.7)	3.0(8.0)	2.8(6.7)	6.3(38.7)
Hand Weedings(2)	20&40 DAS	2.0(2.7)	1.5(1.3)	1.5(1.3)	1.5(1.3)	1.5(1.3)	1.0(0.0)	3.8(13.3)	2.4(4.7)	1.9(2.7)	3.0(8.0)	1.5(1.3)	1.5(1.3)	1.7(2.0)	5.4(28.0)
Untreated	-	4.9(22.7)	3.5(11.3)	4.0(14.7)	3.4(10.7)	3.3(10.0)	3.5(11.3)	10.0(100.0)	5.5(29.3)	4.4(18.7)	4.4(18.7)	3.5(11.3)	3.1(8.7)	3.1(8.7)	6.8(45.3)
SEm+	-	**0.17**	**0.16**	**0.17**	**0.14**	**0.15**	**0.07**	**0.18**	**0.22**	**0.18**	**0.18**	**0.13**	**0.11**	**0.11**	**0.19**
LSD(0.05)	-	**0.51**	**0.48**	**0.52**	**0.42**	**0.45**	**0.22**	**0.53**	**0.67**	**0.56**	**0.55**	**0.38**	**0.36**	**0.33**	**0.58**

Value in parentheses was original and transformed to square root √ X+1 for analysis, SS- Sponsor sample, MS- Market sample, DAA- Days after herbicide application
DAS-Days after sowing

Weed flora

The dominant weed flora of the experimental site at 40 and 60 DAS was similar during both years and comprised of grasses, BLWs and sedges; *Echinochloa colona, Dactyloctenium aegyptium, Digitaria sanguinalis, Digera arvensis, Phyllanthus niruri, Celosia argentia* and *Cyperus rotundus* which account 11.2, 6.0, 7.3, 6.0, 5.6, 6.0 and 57.8%, respectively, in weedy check plot.

Effect on weeds

Weed density and weed dry matter varied significantly under different herbicidal treatments (Table 1,2,3&4). Data presented in Table 1,2,3&4 indicated that all the herbicidal treatments significantly reduced the density and dry matter accumulation of weeds with increasing the dose of 2,4-D EE (Sponsor sample) as compared to market sample of 2,4-D EE at both the stages during both the years and thus ultimately enhanced weed control efficiency. Abdullah *et al*., 2007 also observed that 2,4-D Ester 800g/ha applied as post emergence herbicide significantly reduced the density and dry weight of weeds over weedy check (control). Density of all grassy weeds was recorded minimum with twice hand weeding (20 and 40 DAS). Higher doses of 2,4 D EE (SS) at 900 to 1800 g a.i./ha were found more effective towards reducing the population of *D. arvensis*. Application of 2,4 D EE (SS) applied from 900 to 1800 g a.i./ha and 2,4 D EE (MS) applied at 900 g a.i./ha provided complete control over the density of *P. niruri* and *C.argentia* in 2012 and over *P.niruri* and C.argentia was completely eliminated with the application of 2,4-D EE (SS) at 1350 and 1800 g a.i./ha in 2013. Among the herbicidal treatments, maximum density of BLWs was reported with the application of atrazine applied at 250 g a.i./ha and was significantly greater than all other treatments. Among the differentherbicidal treatments population of *C.rotundus* was obtained minimum with the application of 2,4-D EE (SS) at 1800 g a.i/ha followed by its respective lower dose applied at 1350 g a.i./ha, whereas maximum population was recorded with the application of atrazine applied at 250 g a.i/ha during both the years (Table 1).

Table 2: Effect of treatments on density and total dry weight of weeds at 60 DAA during 2012 and 2013.

Treatments	Dose (g/ha)	2012							2013						
		Weed density (no./m^2) at 60 DAA							Weed density (no./m^2) at 60 DAA						
		E. colona	*D.aegypticum*	*D.sanguinalis*	*D.arvensis*	*P.niruri*	*C.argentia*	*C.rotundus*	*E. colona*	*D.aegypticum*	*D.sanguinalis*	*D.arvensis*	*P.niruri*	*C.argentia*	*C.rotundus*
2,4-D EE 80% EC (SS)	450	4.0(14.7)	3.4(10.7)	3.4(10.7)	2.2(4.0)	1.7(2.0)	2.0(2.7)	4.3(17.3)	4.7(21.3)	4.3(17.3)	4.0(14.7)	2.4(4.7)	1.7(2.0)	2.1(4.0)	4.0(14.7)
2,4-D EE 80% EC (SS)	900	3.8(13.3)	3.3(10.0)	3.3(10.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.4(10.7)	4.6(20.0)	4.3(17.3)	3.8(13.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.1(8.7)
2,4-D EE 80% EC (SS)	1350	3.8(13.3)	3.2(9.3)	3.2(9.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.2(9.3)	4.4(18.7)	4.0(14.7)	3.8(13.3)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.0(8.0)
2,4-D EE 80% EC (SS)	1800	4.0(14.7)	3.2(9.3)	3.3(10.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	3.1(8.7)	4.3(17.3)	3.7(12.7)	3.7(12.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.9(7.3)
2,4-D EE 80% EC (MS)	900	3.8(13.3)	3.3(10.0)	3.2(9.3)	1.5(1.3)	1.0(0.0)	1.7(2.0)	3.5(11.3)	4.7(21.3)	3.8(13.3)	3.6(12.0)	1.5(1.3)	1.0(0.0)	1.9(2.7)	3.1(8.7)
Atrazine 50%WP	250	3.1(8.7)	2.1(3.3)	2.2(4.0)	3.0(8.7)	3.1(8.7)	3.1(8.7)	8.5(72.0)	3.2(9.3)	3.1(8.7)	2.9(7.3)	3.0(8.0)	2.9(7.3)	2.8(6.7)	5.3(26.7)
Hand Weedings(2)	20&40 DAS	1.5(1.3)	1.7(2.0)	1.7(2.0)	1.7(2.0)	1.7(2.0)	1.0(0.0)	4.3(17.3)	3.4(1.7)	2.4(4.7)	2.8(6.7)	1.5(1.3)	1.5(1.3)	1.7(2.0)	5.4(28.0)
Untreated	-	4.3(17.3)	3.2(9.3)	3.5(11.3)	3.2(9.3)	3.1(8.7)	3.2(9.3)	9.5(89.3)	4.7(21.3)	4.0(14.7)	3.9(14.0)	3.2(9.3)	2.9(7.3)	3.0(8.0)	5.4(28.7)
SEm+	-	**0.18**	**0.12**	**0.13**	**0.1**	**0.05**	**0.08**	**0.16**	**0.21**	**0.16**	**0.16**	**0.13**	**0.10**	**0.10**	**0.14**
LSD(0.05)	-	**0.54**	**0.35**	**0.41**	**0.3**	**0.17**	**0.24**	**0.49**	**0.62**	**0.48**	**0.48**	**0.38**	**0.31**	**0.30**	**0.41**

Value in parentheses was original and transformed to square root √ X+1 for analysis, SS- Sponsor sample, MS- Market sample, DAA- Days after herbicide application
DAS-Days after sowing

At 60 DAA, all the weed control treatments registered significantly lower weed density of broad leaf weeds over the weedy check over both years Treatments under evaluation brought about significant variation in the density of all the broad leaf weeds. Density of BLWs decreased with

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respect to increasing doses of 2,4 D EE (SS) from 450 to. 1800 g a.i./ha. Application of 2,4 D EE (SS) from 900 to 1800 g a.i/ha were reported superior in reducing the density of *D. arvensis*, *P.niruri and C.argentia*, whereas, population of *P.niruri* was also completely controlled with the application of 2,4 D EE (MS) applied at 900 g a.i./ha. Among herbicidal treatments, atrazine applied at 250 g a.i./ha was recorded with maximum number of BLWs. None of the herbicides was found much effective in controlling the density of *C. rotundus* completely but among all the treatments its density obtained lowest with the application of 2,4 D EE applied at 1800 g a.i./ha followed by its respective lower dose applied at 1350 g a.i./ha. However, all the treatments was found significantly superior over the weedy check and differences between all the doses of 2,4 D EE (either SS or MS) in controlling the grassy weed density was not significant (Table 2).

Weed dry weight and Weed control efficiency

Weed dry matter is a better parameter to measure the competition than the weed number (Bhanumurthy and Subramanian, 1989).The total dry matter accumulation of weeds was influenced by the different herbicidal treatments at all the stages (40 and 60 DAA). At 40 DAA, complete control over the dry matter accumulation of BLWs was recorded with the application of 2,4 D EE (SS) at 900 to 1800 g a.i./ha followed by the application of 2,4 D EE (MS) applied at 900 g a.i./ha in 2012 and in 2013, it was recorded with 2,4 D EE (SS) 1350 and 1800 g a.i./ha and was at par with its respective lower dose (900 g a.i./ha). Hand weeding was also found effective in controlling the dry weight of BLWs. Among herbicidal treatments lowest dry weight of sedges was obtained with 2,4 D EE (SS) applied at 1800 g a.i./ha. Atrazine applied at 250 g a.i/ha reported highest (3.7 and 3.9 g) dry matter accumulation of BLWs and sedges during both years (Table 3)

Table3: Effect of 2,4-D EE 80% EC on weed dry weight and weed control efficiency at 40 DAA

		2012						2013					
Treatment	**Dose (g a.i./ha)**	**Weed dry weight (g m^{-2})**			**Weed control efficiency (%)**			**Weed dry weight (g m^{-2})**			**Weed control efficiency (%)**		
		Grasses	**Broad leaf weeds**	**Grasses**	**Broad leaf weeds**	**Sedges**	**Grasses**	**Grasses**	**Broad leaf weeds**	**Grasses**	**Grasses**	**Broad leaf weeds**	**Grasses**
2,4-D EE 80% EC (SS)	450	6.3(38.6)	2.3(4.4)	2.3(4.5)	2.8	70.9	69.4	7.5(55.9)	2.9(7.1)	2.5(5.5)	9.8	58.0	38.8
2,4-D EE 80% EC (SS)	900	6.1(36.8)	1.0(0.0)	1.7(1.7)	7.3	100.0	88.4	7.5(55.7)	1.2(0.4)	1.7(2.0)	10.2	97.6	77.8
2,4-D EE 80% EC (SS)	1350	6.0(34.7)	1.0(0.0)	1.6(1.5)	12.6	100.0	89.8	7.3(52.7)	1.0(0.0)	1.7(1.8)	15.0	100.0	80.0
2,4-D EE 80% EC (SS)	1800	6.0(35.7)	1.0(0.0)	1.5(1.2)	10.1	100.0	91.8	7.1(49.3)	1.0(0.0)	1.5(1.3)	20.5	100.0	85.6
2,4-D EE 80% EC (MS)	900	6.2(37.9)	1.3(0.8)	2.1(3.3)	4.5	94.7	77.6	7.4(53.2)	1.4(1.2)	1.8(2.2)	14.2	92.9	75.6
Atrazine 50%WP	250	3.9(14.4)	3.7(12.4)	3.7(12.9)	63.7	17.9	12.2	4.9(22.8)	3.9(13.9)	2.9(7.7)	63.2	17.8	14.4
Hand Weeding	20& 40 DAS	2.1(3.4)	1.4(1.1)	1.7(2.0)	91.4	92.7	86.4	3.9(14.0)	2.0(2.9)	2.5(5.5)	77.4	82.8	38.9
Untreated	-	6.4(39.7)	4.0(15.1)	4.0(14.7)	-	-	-	7.9(62.0)	4.2(16.9)	3.2(9.0)	-	-	-
SEm±		**0.16**	**0.18**	**0.07**	-	-	-	**0.20**	**0.11**	**0.08**	-	-	-
LSD (P=0.05)		**0.50**	**0.56**	**0.20**	-	-	-	**0.60**	**0.33**	**0.23**	-	-	-

Value in parentheses was original and transformed to square root √ X+1 for analysis, SS- Sponsor sample, MS- Market sample, DAA- Days after herbicide application
DAS-Days after sowing

Complete elimination of dry matter accumulation of BLWs was reported with the application of 2,4 D EE (SS) applied at 900 to 1800 g a.i./ha at 60 DAA. Among different herbicidal treatments atrazine applied at 250 g a.i./ha was proved to be inferior in reducing the dry matter accumulation of BLWs and was comparable with the weedy check.

Dry matter accumulation of sedges was greatly influenced with the application of 2,4 D EE (SS) at 1350 and 1800 g a.i./ha in 2012 and 2,4 D EE (SS) at 1800 g a.i./ha in 2013 contributing about 1.8 and 1.7 g of dry weight and was at par with the application of 2,4 D EE (SS) applied at 900 g a.i./ha and 2,4 D EE (MS) applied at 900 g a.i./ha in 2013. Weed control treatments were not found much effective in reducing the dry matter accumulation of grassy weeds except twice hand weeding (Table 4).

The weed control efficiency derived from the weed dry weight revealed that, highest weed control efficiency (91.4 and 86.2%) in 2012 and (77.4 and 62.1%) in 2013 of grassy weeds was recorded with twice hand weeding at 40 and 60 DAA, respectively. Weed control efficiency of broad leaf weeds was recorded maximum (100%) with the application of 2,4 D EE (SS) at 900 and 1800 g a.i./ha at 40 and 60 DAA in 2012 and 2,4 D EE (SS) at 1350 and 1800 g a.i./ha at 40 DAA, whereas, at 60 DAA maximum weed control efficiency (100.0%) of BLWs was also recorded with 2,4-D EE (SS) applied at 900 g a.i./ha in 2013. Highest weed control efficiency of sedges (91.8 and 87.2%) in 2012 and (85.6 and 74.7%) in 2013, was reported with the application of 2,4 D EE (SS) applied at 1800 g a.i/ha at 40 and 60 DAA, respectively.

Table 4: Effect of 2,4-D EE 80% EC on weed dry weight and weed control efficiency at 60 DAA

		2012						2013					
Treatment	**Dose (g a.i./ha)**	**Weed dry weight (g m^{-2})**			**Weed control efficiency (%)**			**Weed dry weight (g m^{-2})**			**Weed control efficiency (%)**		
		Grasses	**Broad leaf weeds**	**Grasses**	**Broad leaf weeds**	**Sedges**	**Grasses**	**Grasses**	**Broad leaf weeds**	**Grasses**	**Grasses**	**Broad leaf weeds**	**Grasses**
2,4-D EE 80% EC (SS)	450	6.6(43.2)	2.8(6.9)	2.3(4.3)	5.3	72.3	76.0	7.8	3.0	2.2	13.9	62.9	49.3
2,4-D EE 80% EC (SS)	900	6.4(40.1)	1.0(0.0)	2.0(2.7)	12.1	100.0	84.9	7.8	1.0	1.8	13.6	100.0	72.0
2,4-D EE 80% EC (SS)	1350	6.4(39.6)	1.0(0.0)	1.8(2.3)	13.2	100.0	87.2	7.6	1.0	1.8	18.3	100.0	72.0
2,4-D EE 80% EC (SS)	1800	6.3(38.9)	1.0(0.0)	1.8(2.3)	14.7	100.0	87.2	7.5	1.0	1.7	20.3	100.0	74.7
2,4-D EE 80% EC (MS)	900	6.3(39.1)	2.0(2.9)	2.0(2.9)	14.3	88.4	83.8	7.8	2.0	1.8	15.3	85.5	72.0
Atrazine 50%WP	250	4.5(19.2)	5.0(23.5)	3.9(14.4)	57.9	5.6	19.5	5.6	4.6	2.8	56.9	10.0	9.3
Hand Weeding	20&40 DAS	2.7(6.3)	2.1(3.5)	2.2(3.7)	86.2	85.9	79.3	5.2	2.2	2.9	62.1	81.9	2.7
Untreated	-	6.8(45.6)	5.1(24.9)	4.3(17.9)	-	-	-	8.4	4.8	2.9	-	-	-
SEm±		**0.14**	**0.05**	**0.09**	**-**	**-**	**-**	**0.20**	**0.09**	**0.06**	**-**	**-**	**-**
LSD (P=0.05)		**0.43**	**0.16**	**0.27**	**-**	**-**	**-**	**0.60**	**0.26**	**0.19**	**-**	**-**	**-**

Value in parentheses was original and transformed to square root √ X+1 for analysis, SS- Sponsor sample, MS- Market sample, DAA- Days after herbicide application
DAS-Days after sowing

Effect on yield and yield attributes (Table 5)

All the yield attributes were significantly influenced by all weed control treatments over the weedy check. Among the different treatments twice hand weeding (20 and 40 DAS) was proved to be superior in gaining higher yield and yield attributing characters. Among the different herbicidal treatments application of atrazine applied at 250 g a.i./ha recorded the higher number of plants (000/ha) and number of cobs (000/ha) and grains/cob by application of 2,4-D EE (SS) applied at 1800 g ai./ha in 2012 and highest number of plants (000/ha), number of cobs (000/ha) and grains/cob in 2013 and was at par with all the doses of 2,4-D EE (SS or MS) except 2,4-D EE (SS) applied at 450 g a.i./ha which were significantly superior than other treatments. Among the different doses of 2,4 D EE (either SS or MS) highest 100 grain weight (g) was observed with the application of atrazine applied at 250 g a.i./ha in 2012 and in 2013, with the application of 2,4-D EE (MS) at 900 g a.i./ha . Application of atrazine applied at 250 g a.i./ha reported the highest grain

Table 5. Effect of herbicidal treatments on yield and yield attributes of maize crop.

Treatments	Dose (g/ha)	Number of Plants ('000'/ha)		Number of cobs ('000'/ha)		No. of Grains/ cob		1000 grain weight(g)		Grain yield (q/ha)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
2,4-D EE 80% EC (SS)	450	53.8	53.8	59.6	59.6	295.0	303.0	19.0	18.3	34.73	36.30
2,4-D EE 80% EC (SS)	900	56.3	61.3	62.2	67.7	315.5	319.9	20.3	19.0	42.50	44.20
2,4-D EE 80% EC (SS)	1350	56.8	62.5	62.8	67.7	316.7	321.1	20.7	19.2	43.17	44.50
2,4-D EE 80% EC (SS)	1800	57.4	63.1	63.2	68.1	317.3	320.0	20.3	19.3	43.67	45.67
2,4-D EE 80% EC (MS)	900	57.6	61.6	62.7	67.0	314.4	318.4	19.6	19.6	42.13	44.53
Atrazine 50%WP	250	58.0	66.7	67.9	69.0	316.9	327.1	21.1	20.6	45.07	45.6
Hand Weeding	20&40D AS	61.0	69.8	71.8	72.8	352.0	340.0	21.2	20.2	51.30	51.6
Untreated	-	43.6	49.6	51.0	51.0	265.1	269.7	19.0	17.9	27.80	30.12
SEm±		**0.09**	**0.9**	**0.05**	**1.0**	**0.08**	**3.9**	**0.04**	**0.5**	**0.08**	**1.18**
LSD (P=0.05)		**0.26**	**2.6**	**0.17**	**3.2**	**0.25**	**11.8**	**0.13**	**NS**	**0.23**	**3.61**

SS- Sponsor sample, MS- Market sample, DAS- Days after sowing

Table 6: Effect of different treatments on plant stand and yield and yield attributes on succeeding crop pea

Treatments	Dose g/ha	Plants No./m^2 (15DAS)		Pods/ Plant		Grains/ pod		100 seed weight (g)		Grain yield (q/ha)	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
2,4-D EE 80% EC (SS)	450	37.7	37.3	16.2	14.1	3.9	3.9	16.1	14.4	19.84	14.51
2,4-D EE 80% EC (SS)	900	38.3	38.0	16.8	13.9	3.7	3.7	16.1	14.7	20.27	15.27
2,4-D EE 80% EC (SS)	1350	37.7	38.3	17.1	13.9	3.8	3.8	16.2	14.5	19.52	14.52
2,4-D EE 80% EC (SS)	1800	37.3	37.3	17.0	13.9	3.9	3.9	15.9	14.6	19.12	14.12
2,4-D EE 80% EC (MS)	900	36.3	36.7	16.5	13.5	3.9	3.9	16.7	14.7	19.75	13.75
Atrazine 50%WP	250	37.8	34.7	17.3	13.4	3.7	3.7	17.2	15.2	20.17	13.68
Hand Weeding	20&40DAS	38.4	38.7	16.5	13.9	3.9	3.4	16.8	14.5	20.00	12.92
Untreated	-	35.6	37.3	16.6	13.7	3.9	3.5	16.0	14.6	20.83	13.08
SEm±		**2.7**	**2.3**	**1.7**	**1.1**	**0.24**	**0.3**	**0.22**	**0.7**	**1.02**	**0.8**
LSD (P= 0.05)		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

SS:Sponsor sample, MS:Market sample

yield of maize i.e. 45.07 q/ha (2012) and 45.6 q/ha (2013) and was found significantly superior than rest of the herbicidal treatments. However, all the treatments were found significantly better than the weedy check. The per cent increase in the grain yield with application of 2,4-D EE (SS) at 1350 and 1800 g a.i./ha and atrazine applied at 250 g a.i./ha was to an extent of 57.08, 55.9 and 62.1% (2012) and 47.7, 51.6 and 51.39% (2013), respectively, over weedy check. Hand weeding (20 and 40 DAS) showed 84.53% (2012) and 81.0% (2013) increase in the yield of maize crop over weedy check. Ali *et al.* (2003) also reported that weed control treated plots increased yield as compared to check

Effect on succeeding pea crop

All yield and yield attributing characters were not influenced significantly due to weed control treatments (Table 6) and they were statistically similar and at par to each other, including weedy check plots. Post emergence application of 2,4-D EE 80% EC against weeds in maize crop during *kharif* season was safe for growing pea crop in *Rabi* season.

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